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(73) Proprietor : FUJI PHOTO FILM CO., LTD.
210 Nakanuma
Minami-Ashigara-shi
Kanagawa 250-01 (JP)

(72) Inventor : Ogura, Nobuhiko c/o Fuji Photo Film Co., Ltd.
798 Miyanodai
Kaisei-machi
Ashigarakami-gun Kanagawa-ken (JP)

(74) Representative : Patentanwälte Grünecker, Kinkeldey, Stockmair & Partner
Maximilianstrasse 58
D-80538 München (DE)

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Description

BACKGROUND OF THE INVENTION

Field of the Invention

This invention relates to a reflection density measuring system in which light is projected onto a surface to be measured and reflected light from the measured surface is received by a photodetector, whereby the reflection density of the surface is measured.

Description of the Prior Art

There has been put into practice a dry-type chemical assay slide for quantitative analysis of a particular component contained in a droplet of a sample liquid such as blood or urine. See for example JP-A-53(1978)-21677, JP-A-55(1980)-164356.

When analyzing chemical components in a sample liquid using such a chemical assay slide, a droplet of the sample liquid is deposited on the slide and is held at a constant temperature for a predetermined time in an incubator to permit coloring reaction, and the optical density of the color formed by the coloring reaction is optically measured. That is, measuring light containing a wavelength selected in advance according to the combination of the component to be measured in the sample liquid and the reagent contained in the reagent layer of the slide is projected onto the chemical assay slide and the optical density of the reflected light is measured. Then the content of the component to be measured is quantified on the basis of the optical density of the reflected light by colorimetry.

The optical density of the reflected light is measured by a reflection density measuring system. In the reflection density measuring system, a sample or a chemical assay slide is mounted on the system, light is projected onto a surface of the slide to be measured and reflected light from the surface to be measured is received by a photodetector.

In such a reflection density measuring system, there has been a problem that the position of the measured surface of the sample can fluctuate in the direction perpendicular to the measured surface due to fluctuation in the positioning accuracy or the dimensional accuracy of the slide, deflection of the slide, and the like. When the position of the measured surface fluctuates in the direction perpendicular thereto, the relative position between the measured surface and the photodetector varies to change the r sult of the measurement.

A reflection density measuring system according to the preamble of claim 1 is known from EP-A-0 099 024. This known system is designed, to make the measurement of the surface independent from th correct distance. It is proposed, to use at least two light sources, which produce diverging light. A singl receiving device is arranged between the two light sources and receives the light reflected from the surface. The distance between the light sources and the surface and the receiving device and the surface is kept constant.

US-A-3 526 777 shows a reflection measuring apparatus, for the measuring of products such as paper. Changes in distance between the surface, which is to be measured and a light source, irradiating light to said surface and the measuring apparatus are compensated by an arrangement of lenses and apertures, such that when the surface moves closer to the light source and the measuring apparatus, the amount of light which is emitted to pass through certain apertures to the measuring apparatus is reduced in such a manner as to provide the desired compensation.

SUMMARY OF THE INVENTION

It is the object of the present invention to provide a reflection density measuring system, in which the result of the measurement is less affected by a fluctuation in the position of the measured surface, perpendicular to the measured surface.

This object is solved according the present invention by the subject matter of claim 1.

Preferred embodiments of the invention are subject matter of the dependent claims 2 to 4.

When the angle θ and the distance r are suitably selected, the output curve representing the relation between the distance h and the output I of the photosensor is generally an arch-like curve and the output I of the photosensor takes a peak value at a predetermined value of the distance h. The values r_o and θo are selected so that the output curve becomes an arch-like curve and the value h_o is selected to be the value corresponding to a peak value of the output I of the photosensor. Near the peak, the output of the photosensor exhibits substantially no change with change in the distance h. The value of h_o need not be strictly equal to the value corresponding to the peak value but may be substantially equal to the same.

In accordance with the present invention, the photodetector may solely consist of a photosensor or may comprise a photosensor and a lens or an optical stop disposed in front of the photosensor. The term "the light inlet side element" denotes the photosensor itself in the former case and denotes the lens or the optical stop in the latter case.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a schematic view for illustrating a reflection density measuring system in accordance with an embodiment of the present invention,

Figure 2 is a view for illustrating the principle of operation of the mbodiment shown in Figure 1,
Figures 3 and 4 are views similar to Figure 1 but showing modifications of the system shown in Figure 1,
Figure 5 is a schematic view illustrating the reflection density measuring system in accordance with another embodiment of the present invention,
Figure 6 is a block diagram of the circuit for determining the reflection density on the basis of the outputs of the photosensor in the embodiment of Figure 5,
Figure 7 is a view for illustrating the principle of operation of the embodiment of Figure 5,
Figure 8 is a view similar to Figure 6 but showing the circuit for determining the reflection density on the basis of the outputs of the photosensors in still another embodiment of the present invention,
Figure 9 is a view for illustrating the principle of operation of the embodiment of Figure 8, and
Figures 10 and 11 are views similar to Figure 5 but showing modifications of the system shown in Figure 5.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

In Figure 1, a reflection density measuring system in accordance with an embodiment of the present invention comprises a sample holder 12 for holding a sample 10, a light source 14 for emitting irradiation light, fiber optics 16 for guiding the irradiation light to impinge upon a surface-to-be-measured 10a of the sample 10 at a direction perpendicular thereto, a condenser lens 18 for condensing the irradiation light emanating from the fiber optics 16, and a photodetector 30 which has a photosensor 20 such as a silicon photodiode and receives reflection light from the surface-to-be-measured 10a.

The fiber optics 16, the condenser lens 18, the sample holder 12 and the photosensor 20 are arranged so that when a sample of a regular size is held by the sample holder 12 in a regular position, the distance h between the center 20a of the photosensor 20 and the surface-to-be-measured 10a of the sample 10 as measured along the optical axis 22 of the irradiation light is ho, the angle θ which the photosensor 20 forms with the surface-to-be-measured 10a is θo, and the distance r between the center 20a of the photosensor 20 and the optical axis 22 of the irradiation light is ro; and so that ho is the value of h at which output I of the photosensor 20 takes a peak value on an output curve representing the change of the output I of the photosensor 20 with the distance h when the distance h is varied under the combination of ro and θo.

That is, in the optical system shown in Figure 1, when the angle θ and the distance r are suitably selected, the output curve representing the r lation between the distance h and the output I of the photosensor 20 is generally an arch-like curve and the output I of the photosensor 20 takes a peak value at a predetermined value of the distance h. The values ro and θo are selected so that the output curve becomes an arch-like curve and the value ho is selected to be the value corresponding to a peak value of the output I of the photosensor 20.

An example of the arch-like output curve is shown in Figure 2. The output curve shown in Figure 2 represents the change of the output I of the photosensor 20 with the distance h when the distance h is varied from about 5.0mm to about 6.5mm with ro being 8.75mm and θo being 45°. As can be seen from Figure 2, the output I takes a peak value when the distance h is about 5.7mm in this case.

Since the value ho is selected to be the value of the distance h corresponding to the peak value of the output I of the photosensor 20, a change of the actual distance h between the surface-to-be-detected 10a and the center 20a of the photosensor 20 as measured along the optical axis 22 near the value ho which can occur due to fluctuation in the positioning accuracy or the dimensional accuracy of the slide, deflection of the slide, and the like can fluctuate the output I of the photosensor only by a slight value indicated at ΔI_1. The value ΔI_1 is much smaller than the value of ΔI_2 which is the fluctuation of the output I when the distance h is varied for the same value from a value which is not corresponding to the peak value of the output I.

Though in the embodiment described above, the values ro and θo are selected so that the output curve becomes an arch-like curve, the values may be selected to provide an output curve of a different shape so long as the curve has a peak value or an inflection point.

Figures 3 and 4 show modifications of the optical system shown in Figure 1. In the figures, the parts analogous to the parts shown in Figure 1 are given the same reference numerals and are not further described. In the modifications shown in Figure 3, the photodetector 30 comprises a photosensor 20 and a lens 24 disposed in front of the photosensor 20. In this modification, the fiber optics 16, the condenser lens 18, the sample holder 12 and the photodetector 30 are arranged so that when a sample of a regular size is held by the sample holder 12 in a regular position, the distance h between the center 24a of the lens 24 and the surface-to-be-measured 10a of the sample 10 as measured along the optical axis 22 of the irradiation light is ho, the angle θ which the lens 24 forms with the surface-to-be-measured 10a is θo, and the distance r between the cent r 24a of the lens 24 and the optical axis 22 of the irradiation light is ro, so that

ho is the value of h at which output I of the photosensor 20 takes a peak value on an output curve r presenting the change of the output I of the photosensor 20 with the distance h when the distance h is varied under the combination of ro and θo.

In the modification shown in Figure 4, the photodetector 30 comprises a photosensor 20 and an optical stop 26 having an aperture 28 disposed in front of the photosensor 20. In this modification, the fiber optics 16, the condenser lens 18, the sample holder 12 and the photodetector 30 are arranged so that when a sample of the regular size is held by the sample holder 12 in the regular position, the distance h between the center 26a of the stop 26 (the center 28a of the aperture 28) and the surface-to-be-measured 10a of the sample 10 as measured along the optical axis 22 of the irradiation light is ho, the angle θ which the stop 26 forms with the surface-to-be-measured 10a is θo, and the distance r between the center 26a of the stop 26 and the optical axis 22 of the irradiation light is ro, so that ho is the value of h at which output I of the photosensor 20 takes a peak value on an output curve representing the change of the output I of the photosensor 20 with the distance h when the distance h is varied under the combination of ro and θo.

Also in the modifications shown in Figures 3 and 4, since the value ho is selected to be the value of the distance h corresponding to the peak value of the output I of the photosensor 20, a change of the actual distance h between the surface-to-be-detected 10a and the center 24a of the lens 24 or the center 26a of the stop 26 as measured along the optical axis 22 near the value ho can fluctuate the output I of the photosensor only by a slight value. In the embodiment described above, only a single photodetector is provided. However, a plurality of photodetectors may be provided. In this case, at least one of the photodetectors should be positioned to meet the condition described above.

Figures 5 and 6 show still another embodiment of the present invention. In Figure 5, the system of this embodiment comprises a sample holder 112 for holding a sample 110, a light source 114 for emitting irradiation light, fiber optics 116 for guiding the irradiation light to impinge upon a surface-to-be-measured 110a of the sample 110 perpendicular thereto, a condenser lens 118 for condensing the irradiation light emanating from the fiber optics 116, and first and second of photodetectors 30a and 30b which respectively have photosensors 301a and 301b such as silicon photodiodes and receive reflection light from the surface-to-be-measured 110a.

The fiber optics 116, the condenser lens 118, the sample holder 112 and the photosensors 301a and 301b are arranged so that when a sample of a regular size is held by the sample holder 112 in a regular position, the distances h between the center 302a of the first photosensor 301a and a regular position of the surface-to-be-measured 110a of the sample 110 and betw en the cent r 302b of the second photosensor 301b and the regular position as measured along the optical axis 122 of the irradiation light are respectively h_1 and h_2, the angles θ which the photosensors 301 and 301b respectively form with the surface-to-be-measured 110a are θ1 and θ2, and the distances r between the center 302a of the first photosensor 301a and the optical axis 122 of the irradiation light and between the center 302b of the second photosensor 301b and the optical axis 122 are respectively r_1 and r_2 so that h_1 is smaller by Δh_1 than value h_{10} which is the value of h at which output I_1 of the first photosensor 301a takes a peak value on an output curve representing the change of the output I_1 with the distance h when the distance h is varied under the combination of r_1 and θ_1, and h_2 is larger by Δh_2 than value h_{20} which is the value of h at which output I_2 of the second photosensor 301b takes a peak value on an output curve representing the change of the output I_2 with the distance h when the distance h is varied under the combination of r_2 and θ_2.

That is, in the optical system shown in Figure 5, when the angle θ and the distance r are suitably selected, the output curve representing the relation between the distance h and the output I of the photosensor is generally an arch-like curve and the output I of the photosensor takes a peak value at a predetermined value of the distance h. The values r_1 and θ_1, and values r_2 and θ_2 are selected so that the output curves of the corresponding photosensors become arch-like curves and the value h_1 is selected to be smaller by Δh_1 than the value h_{10} which is the value of h at which the output I_1 of the first photosensor 301a takes a peak value on the arch-like output curve representing the change of the output I_1 and h_2 is selected to be larger by Δh_2 than the value h_{20} which is the value of h at which the output I_2 of the second photosensor 301b takes a peak value on the arch-like output curve representing the change of the output I_2.

In this embodiment, the first and second photosensors 301a and 301b are connected to an adder 140 as shown in Figure 6, and the outputs I_1 and I_2 of the first and second photosensors 301a and 301b are added together by the adder 140. The reflection density of the sample 110 is determined on the basis of the output of the adder 140 or the sum I_t of the outputs I_1 and I_2.

Figure 7 shows the relations between the distance h and the output I_1, between the distance h and the output I_2, and between the distance h and the sum I_t of the outputs I_1 and I_2. Since the first and second photosensors 301a and 301b are disposed as described above, the output I_1 of the first photosensor 301a takes the peak value when the surface-to-be-measured 110a is positioned higher than the regular position S of the surface-to-be-measured 110a of the sample 110 by Δh_1 and the output I_2 of the second

photosensor 301b takes the peak value when the surface-to-be-measured 110a is positioned lower than the regular position S (on a sample of the regular size held by the sample holder 112 in the regular position) by Δh_2 as can be understood from Figure 7. Accordingly, the sum I_t of the outputs I_1 and I_2, i.e., the output of the adder 140 has a substantially flat peak F extending on opposite sides of the value of h corresponding to the regular position S in lengths respectively corresponding to the values of Δh_1 and Δh_2. Therefore, in accordance with this embodiment, the output I_t of the adder 140 exhibits substantially no change even if the position of the surface-to-be-measured 110a fluctuates along the optical axis 122 of the irradiation light so long as the surface-to-be-measured 110a is positioned in the range corresponding to the peak F having a substantial width, and accordingly positioning accuracy of the sample 110 less affects measuring accuracy of optical density of the sample 110. It is preferred, though not necessary, that Δh_1 and Δh_2 are equal to each other in value.

Still another embodiment of the present invention will now be described with reference to Figures 8 and 9. The optical density measuring system of this embodiment has an optical system identical to the optical system shown in Figure 5 and differs from the preceding embodiment in that the photosensors 301a and 310b are connected to a comparison selective output circuit 150 instead of the adder 140. The comparison selective output circuit 150 compares the outputs of the photosensors 301a and 301b and outputs the higher of them (I_h). The reflection density of the sample 110 is determined on the basis of the output of the comparison selective output circuit 150 or the higher one of the outputs of the photosensors 301a and 301b of the first and second photodetectors 30a and 30b.

Figure 9 shows the relations between the distance h and the output I_1, between the distance h and the output I_2, and between the distance h and the output I_h of the comparison selective output circuit 150. The output curves of the outputs I_1 and I_2 are as described above in conjunction with the preceding embodiment and accordingly the output curve of the output I_h has two peaks on opposite sides of the value of h corresponding to the regular position S of the surface-to-be-measured 110a of the sample positioned in the regular position as shown by the solid line in Figure 9, the peaks respectively corresponding to the peaks of the output curves of the outputs I_1 and I_2.

As described above in conjunction with the embodiment shown in Figure 1, the output of the photosensor exhibits only a slight change with change in the distance h near a peak of the output curve and accordingly by measuring the reflection density near the peak of the output curve, the reflection density can be precisely measured ven if the sample 110 is displaced from the regular position within a certain range. For example, assuming that the reflection density is measured on the basis of only the output I_2 of the second photosonsor 301b as in the embodiment shown in Figure 1, the sample 110 may be displaced from the regular position by Δh_2 on opposite sides of the peak. That is, in this case, the vertical (along the optical axis of the irradiation light) displacement of the sample 110 from the regular position within Δh_2 on each side of the regular position can be allowed. That is, the allowable range of the vertical displacement of the sample 110 is $2 \cdot \Delta h_2$. On the other hand, in the case of this embodiment in which the reflection density is determined on the basis of the higher of the outputs I_1 and I_2 of the first and second photosensors 301a and 301b, the allowable range of the vertical displacement of the sample 110 is further widened to $2 \cdot \Delta h_1 + 2 \cdot \Delta h_2$ as can be understood from Figure 9. Also in this embodiment, it is preferred, though not necessary, that Δh_1 and Δh_2 be equal to each other.

Though in the two embodiments described with reference to Figures 5 to 9, the values r_1 and θ_1, or the values r_2 and θ_2 are selected so that the output curve becomes an arch-like curve, the values may be selected to provide an output curve of a different shape so long as the curve has a peak value or an inflection point.

Figures 10 and 11 show modifications of the optical system shown in Figure 5.

In the modification shown in Figure 10, the first and second photodetectors 30a and 30b comprise photosensors 301a and 301b and lenses 303a and 303b disposed in front of the photosensors 301a and 301b. The fiber optics 116, the condenser lens 118, the sample holder 112 and the photodetectors 30a and 30b are arranged so that when a sample of the regular size is held by the sample holder 112 in the regular position, the distances h between the center 304a of the lens 303a and a regular position of the surface-to-be-measured 110a of the sample 110 and between the center 304b of the lens 303b and the regular position as measured along the optical axis 122 of the irradiation light are respectively h_1 and h_2, the angles θ which the lenses 303a and 303b respectively form with the surface-to-be-measured 110a are $\theta 1$ and $\theta 2$, and the distances r between the center 304a of the lens 303a and the optical axis 122 of the irradiation light and between the center 304b of the lens 303b and the optical axis 122 are respectively r_1 and r_2 and so that h_1 is smaller by Δh_1 than value h_{10} which is the value of h at which output I_1 of the first photosensor 301a takes a peak value on an output curve representing the change of the output I_1 with the distance h when the distance h is varied under the combination of r_1 and θ_1, and h_2 is larg r by Δh_2 than value h_{20} which is the value of h at which output I_2 of the second photosensor 301b takes a peak value on an output curve representing the chang of the output I_2 with the distance h when the distance h is varied un-

der the combination of r_2 and θ_2.

In the modification shown in Figur 11, th first and second photodetectors 30a and 30b comprise photosensors 301a and 301b and optical stops 303a and 306b respectively having apertures 305a and 305b disposed in front of the photosensors 301a and 301b. The fiber optics 116, the condenser lens 118, the sample holder 112 and the photodetectors 30a and 30b are arranged so that when a sample of the regular size is held by the sample holder 112 in the regular position, the distances $\underline{h}$ between the center 307a of the aperture 305a (the stop 306a) and a regular position of the surface-to-be-measured 110a of the sample 110 and between the center 307b of the aperture 305b (the stop 306b) and the regular position as measured along the optical axis 122 of the irradiation light are respectively h_1 and h_2, the angles θ which the stops 306a and 306b respectively form with the surface-to-be-measured 110a are $\theta 1$ and $\theta 2$, and the distances $\underline{r}$ between the center 307a of the aperture 307a and the optical axis 122 of the irradiation light and between the center 307b of the aperture 307b and the optical axis 122 are respectively r_1 and r_2 so that h_1 is smaller by Δh_1 than value h_{10} which is the value of $\underline{h}$ at which output I_1 of the first photosensor 301a takes a peak value on an output curve representing the change of the output I_1 with the distance $\underline{h}$ when the distance $\underline{h}$ is varied under the combination of r_1 and θ_1, and h_2 is larger by Δh_2 than value h_{20} which is the value of $\underline{h}$ at which output I_2 of the second photosensor 301b takes a peak value on an output curve representing the change of the output I_2 with the distance $\underline{h}$ when the distance $\underline{h}$ is varied under the combination of r_2 and θ_2.

The optical systems shown in Figures 10 and 11 may be associated with either of the circuits shown in Figure 6 and 8 to obtain the same results as one of the embodiments described above in conjunction with Figures 5 to 9.

Though in the embodiments shown in Figures 5 to 9, a pair of photodetectors are provided, three or more photodetectors may be used. In this case, at least two of the photodetectors should be positioned to meet the condition described above. Further, it is preferred, that the third photodetector be disposed so that its output takes a peak value at the value of $\underline{h}$ corresponding to the regular position of the surface-to-be-measured 110a.

Claims

1. A reflection density measuring system comprising:
   m ans including a light source (14) for projecting an irradiation light onto the surface-to-be-measur d (10a) of a sample (10) ;
   one or two photodetectors (30;30a,30b) which have a photosensor (20;301a,301b) respectively for detecting light reflected by the surface-to-be-measured of the sampl , to impinge upon the photosensor through a light inlet side element of (24,26) the photodetector,
   characterized in
   that the light emitted by said light source (14) is guided through a condenser lens (18) for condensing the irradiation light and impinges upon the surface-to-be-measured (10a) of a sample (10) essentially at a direction perpendicular thereto,
   that the light inlet side element of the photodetector is arranged in a plane to form an angle (θ_0; θ_1, θ_2) with the surface-to-be-measured of the sample,
   that the center of the light inlet side element of each photodetector has a sideward distance (r_0;r_1,r_2), to the optical axis of said condenser lens,
   that the measuring distance defined by the distance (h) of the center of said light inlet side element of each photodetector to the plane, in which said surface (10a) of said sample (10) is arranged, is less than the distance of said condensor lens to said surface (10a) of said sample,
   that when one photodetector is used, the measuring distance (h_0) of said center of the light inlet side element of the photodetector to the surface-to-be-measured is such, that the output ($\underline{I}$) of said photosensor is equal to the peak value on the output curve representing the output of the photosensor as a function of the measuring distance (h), at a predetermined value of the sideward distance (r_0) and said angle (θ_0), and
   that when two photodetectors are used, the measuring distance (h_1) of the first photodetector is such that it is smaller by a preselected value (Δh_1) than the measuring distance (h_{10}) at which the ouput of said first photosensor is equal to the peak value of the output curve representing the output (I_1) as a function of the measuring distance ($\underline{h}$), at a predetermined value of the respective sideward distance (r_1) and respective angle (θ_1) and that the measuring distance (h_2) of the second photodetector is such that said distance is larger by a preselected value (Δh_2) than a value (h_{20}) which is the value of the distance ($\underline{h}$) at which the output (I_2) of the photosensor of the second photodetector is equal to the peak value of the output curve representing the output (I_2) as a function of the measuring distance ($\underline{h}$) at a predetermined value of the respective sideward distance (r_2) and respectiv angle (θ_2).

2. A reflection density measuring system as defined in Claim 1 in which each of said photodetectors solely consists of a photosensor and said light in-

let side element is the photosensor itself.

3. A reflection density measuring system as defined in Claim 1 in which each of said photodetectors comprises a photosensor and a lens disposed in front of the photosensor and said light inlet side element is the lens.

4. A reflection density measuring system as defined in Claim 1 in which each of said photodetector comprises a photosensor and an optical stop disposed in front of the photosensor and said light inlet side element is the optical stop.

Patentansprüche

1. Reflektometer, das aufweist:
eine Einrichtung mit einer Lichtquelle (14) zum Projizieren eines Bestrahlungslichtes auf die Meßfläche (10a) einer Probe (10);
ein oder zwei Fotodetektoren (30; 30a, 30b), die jeweils einen Fotosensor (20; 301a, 301b) zum Detektieren des von der Meßfläche der Probe reflektierten Lichtes aufweisen, das auf den Fotosensor durch ein Lichteingangsseitenelement (24, 26) des Fotodetektors auftrifft,
dadurch gekennzeichnet,
daß das von der Lichtquelle (14) ausgesendete Licht zum Bündeln des Bestrahlungslichtes durch eine Kondensorlinse (18) geführt ist und auf die Meßfläche (10a) der Probe (10) im wesentlichen senkrecht auftrifft,
daß das Lichteingangsseitenelement des Fotodetektors in einer Ebene angeordnet ist, die einen Winkel (θ_0; θ_1, θ_2) mit der Meßfläche der Probe bildet,
daß die Mitte des Lichteingangsseitenelementes von jedem Fotodetektor einen seitlichen Abstand (r_o; r_1, r_2) zu der optischen Achse der Kondensorlinse aufweist,
daß der Meßabstand, der definiert ist durch den Abstand (h) der Mitte des Lichteingangsseitenelementes von jedem Fotodetektor zu der Ebene, in der die Fläche (10a) der Probe (10) angeordnet ist, kleiner ist als der Abstand der Kondensorlinse zu der Meßfläche (10a) der Probe,
daß bei Nutzung eines Fotodetektors der Meßabstand (h_o) der Mitte des Lichteingangsseitenelementes des Fotodetektors zu der Meßoberfläche derart ist, daß der Ausgang (I) des Fotosensors gleich dem Spitzenwert an der Ausgangskurve ist, die den Ausgang des Fotosensors als Funktion des Meßabstandes (h) für einen vorbestimmten Wert d s seitlichen Abstandes (r_o) und des Winkels (θ_o) darstellt, und
daß bei Nutzung von zwei Fotodetektoren der Meßabstand (h_1) des ersten Fotodetektors derart ist, daß er um einen vorgewählten Wert (Δh_1) kleiner ist als d r Meßabstand (h_{10}), bei dem der Ausgang des ersten Fotosensors gleich dem Spitzenwert der Ausgangskurve ist, die den Ausgang (I_1) als eine Funktion des Meßabstandes ($\underline{h}$) bei einem vorbestimmten Wert des jeweiligen seitlichen Abstandes (r_1) und des jeweiligen Winkels (θ_1) darstellt, und daß der Meßabstand (h_2) des zweiten Fotodetektors derart ist, daß der Abstand um einen vorgewählten Wert (Δh_2) größer als ein Wert (h_{20}) ist, der der Wert des Abstandes ($\underline{h}$) ist, bei dem der Ausgang (I_2) des Fotosensors des zweiten Fotodetektors gleich dem Spitzenwert der Ausgangskurve ist, die den Ausgang (I_2) als eine Funktion des Meßabstandes ($\underline{h}$) bei einem vorbestimmten Wert des jeweiligen seitlichen Abstandes (r_2) und des jeweiligen Winkels (θ_2) darstellt.

2. Reflektometer nach Anspruch 1, **dadurch gekennzeichnet**, daß jeder Fotodetektor nur aus einem Fotosensor besteht und das Lichteingangsseitenelement der Fotosensor selbst ist.

3. Reflektometer nach Anspruch 1, **dadurch gekennzeichnet**, daß jeder Fotodetektor einen Fotosensor und eine Linse, die vor dem Fotosensor angeordnet ist, aufweist, und das Lichteingangsseitenelement die Linse ist.

4. Reflektometer nach Anspruch 1, **dadurch gekennzeichnet**, daß jeder Fotodetektor einen Fotosensor und eine Blende, die vor dem Fotosensor angeordnet ist, aufweist, und das Lichteingangsseitenelement die Blende ist.

Revendications

1. Système de mesure de densité de réflexion comprenant :
un moyen incluant une source de lumière (14) pour projeter une lumière d'irradiation sur la surface qui doit être mesurée (10a) d'un échantillon (10) ;
un ou deux photodétecteurs (30 ; 30a, 30b) qui comportent respectivement un photocapteur (20 ; 301a, 301b) pour détecter la lumière réfléchie par la surface qui doit être mesurée de l'échantillon afin qu'elle arrive en incidence sur le photocapteur au travers d'un élément de côté d'entrée de lumière (24, 26) du photodétecteur,
caractérisé en ce que :
la lumière émise par ladite source de lumière (14) est guidé au travers d'une lentill de condenseur (18) permettant de condenser la lumière d'irradiation et elle arrive n incidence sur la surface qui doit être mesurée (10a) d'un

échantillon (10) essentiellement selon une direction perpendiculaire à celle-ci ;

l'élément de côté d'entrée de lumière du photodétecteur est agencé dans un plan qui forme un angle (θ_0 ; θ_1, θ_2) avec la surface qui doit être mesurée de l'échantillon ;

le centre de l'élément de côté d'entrée de lumière de chaque photodétecteur présente une distance latérale (r_0 ; r_1, r2) par rapport à l'axe optique de ladite lentille de condenseur ;

la distance de mesure définie par la distance (h) du centre dudit élément de côté d'entrée de lumière de chaque photodétecteur par rapport au plan, dans lequel ladite surface (10a) dudit échantillon (10) est agencée, est inférieure à la distance de ladite lentille de condenseur par rapport à ladite surface (10a) dudit échantillon ;

lorsqu'un seul photodétecteur est utilisé, la distance de mesure (h_0) dudit centre de l'élément de côté d'entrée de lumière du photodétecteur par rapport à la surface qui doit être mesurée est telle que la sortie (I) dudit photocapteur est égale à la valeur de pic sur la courbe de sortie représentant la sortie du photocapteur en fonction de la distance de mesure (h), pour une valeur prédéterminée de la distance latérale (r_0) et dudit angle (θ_0) ; et

lorsque deux photodétecteurs sont utilisés, la distance de mesure (h_1) du premier photodétecteur est telle qu'elle est inférieure d'une valeur présélectionnée (Δh_1) à la distance de mesure (h_{10}) pour laquelle la sortie dudit premier photocapteur est égale à la valeur de pic de la courbe de sortie représentant la sortie (I_1) en fonction de la distance de mesure (h) pour une valeur prédéterminée de la distance latérale respective (r_1) et de l'angle respectif (θ_1) et en ce que la distance de mesure (h_2) du second photodétecteur est telle que ladite distance est supérieure d'une valeur présélectionnée (Δh_2) à une valeur (h_{20}) qui est la valeur de la distance (h) pour laquelle la sortie (I_2) du photocapteur du second photodétecteur est égale à la valeur de pic de la courbe de sortie représentant la sortie (I_2) en fonction de la distance de mesure (h) pour une valeur prédéterminée de la distance latérale respective (r_2) et de l'angle respectif (θ_2).

2. Système de mesure de densité de réflexion selon la revendication 1, dans lequel chacun desdits photodétecteurs est constitué seulement par un photocapteur et ledit élément de côté d'entrée de lumière est le photocapteur lui-même.

3. Système de mesure de densité de réflexion selon la revendication 1, dans lequel chacun desdits photodétecteurs comprend un photocapteur et une lentille disposée à l'avant du photocapteur et ledit élément de côté d'entrée de lumière est la lentille.

4. Système de mesure de densité de réflexion selon la revendication 1, dans lequel chaque dit photodétecteur comprend un photocapteur et un arrêt optique disposé à l'avant du photocapteur et ledit élément latéral d'entrée de lumière est l'arrêt optique.

FIG.1

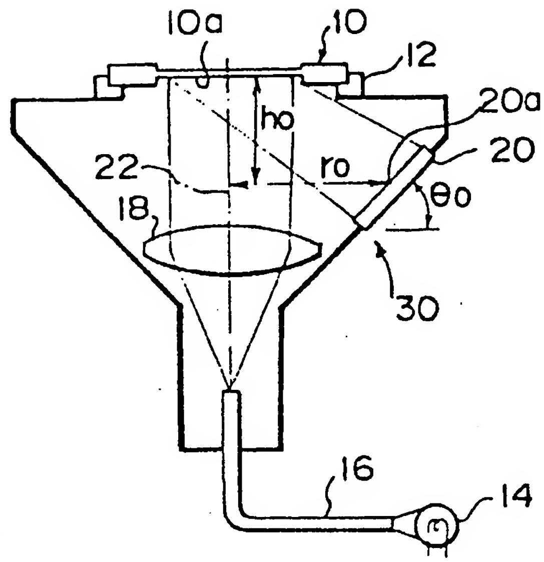


FIG.2

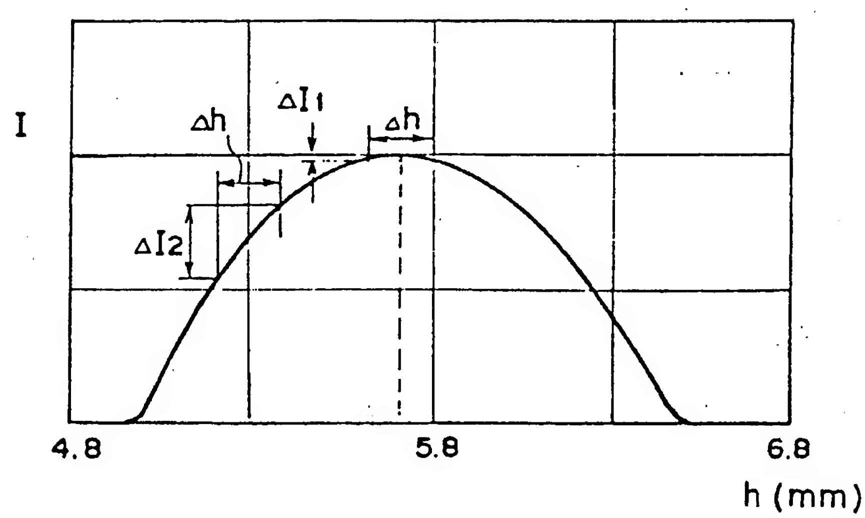


FIG.3

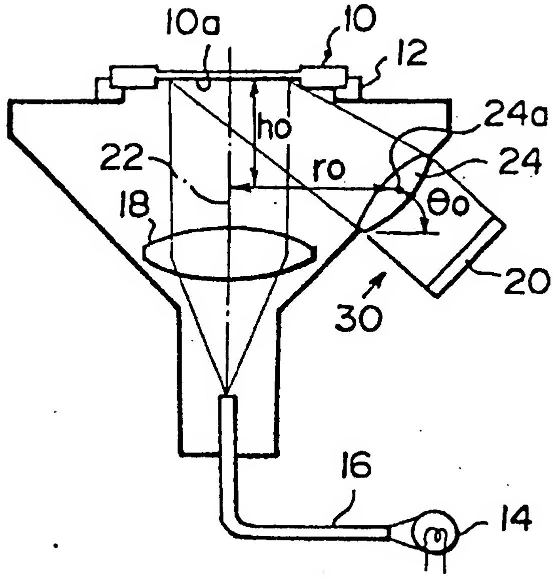

10a
10
12
ho
24a
22
ro
24
18
θo
20
30
16
14

FIG.4

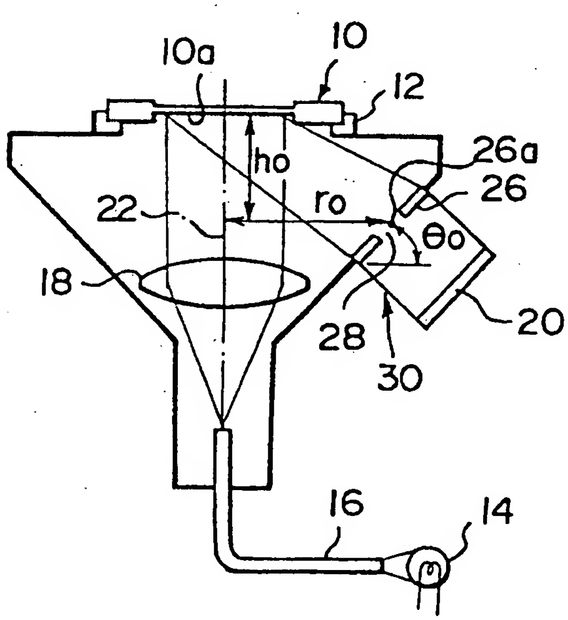

10a
10
12
ho
26a
26
22
ro
θo
18
20
28
30
16
14

FIG.5

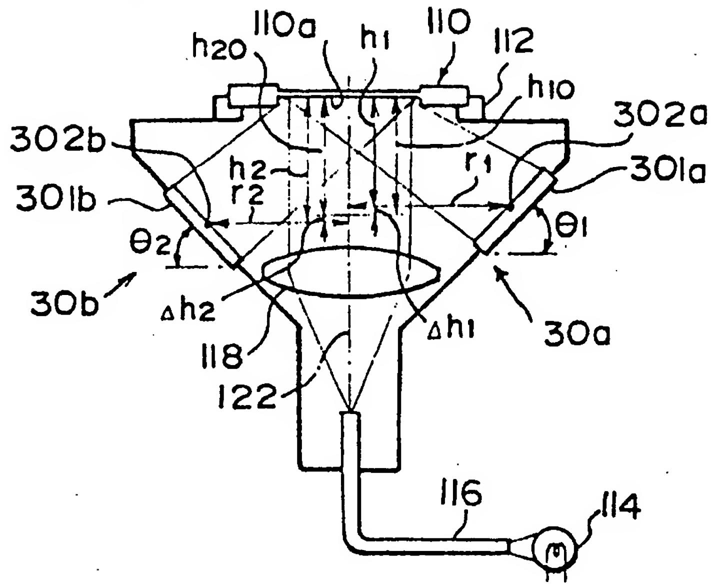


FIG.6

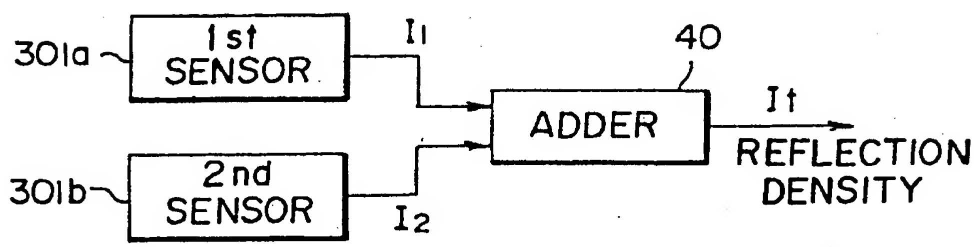


FIG.8

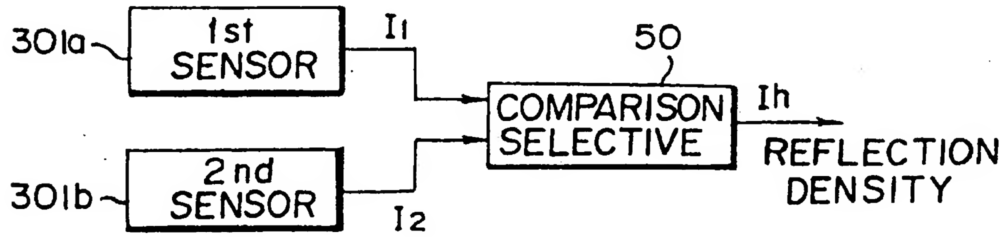


FIG.7

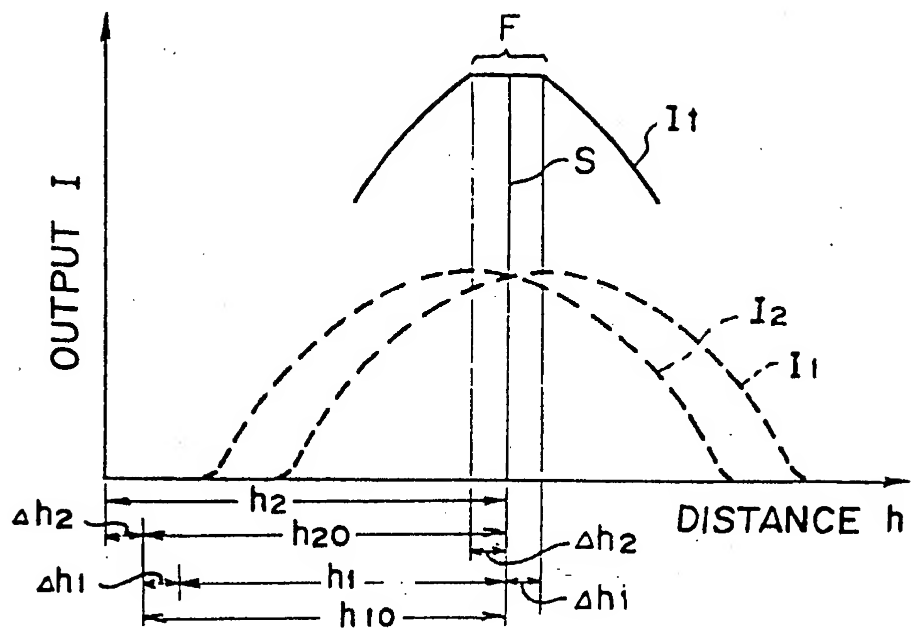

F
I1
S
OUTPUT I
I2
I1
DISTANCE h
h2
Δh2
h20
Δh2
Δh1
h1
Δh1
h10

FIG.9

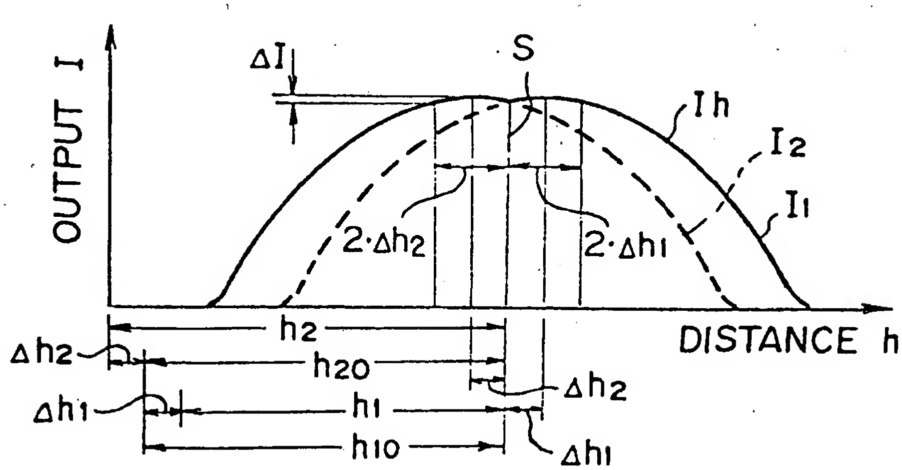

ΔI
S
Ih
I2
OUTPUT I
I1
2·Δh2
2·Δh1
DISTANCE h
h2
Δh2
h20
Δh2
Δh1
h1
h10
Δh1

FIG.10

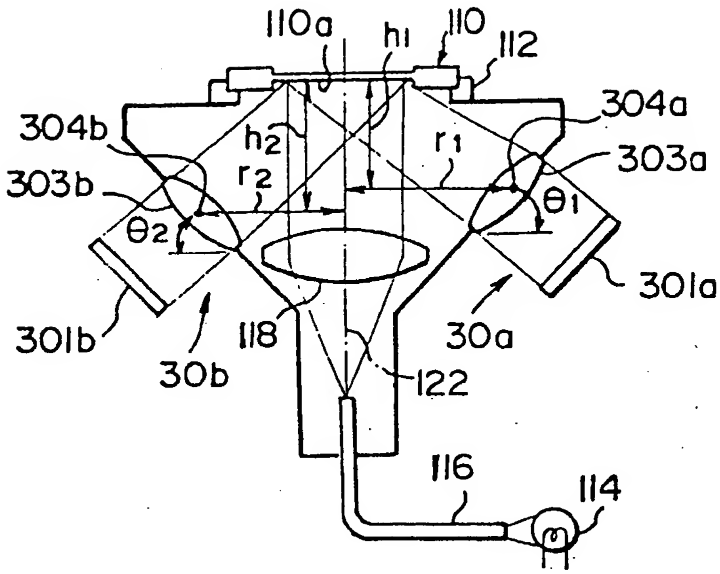
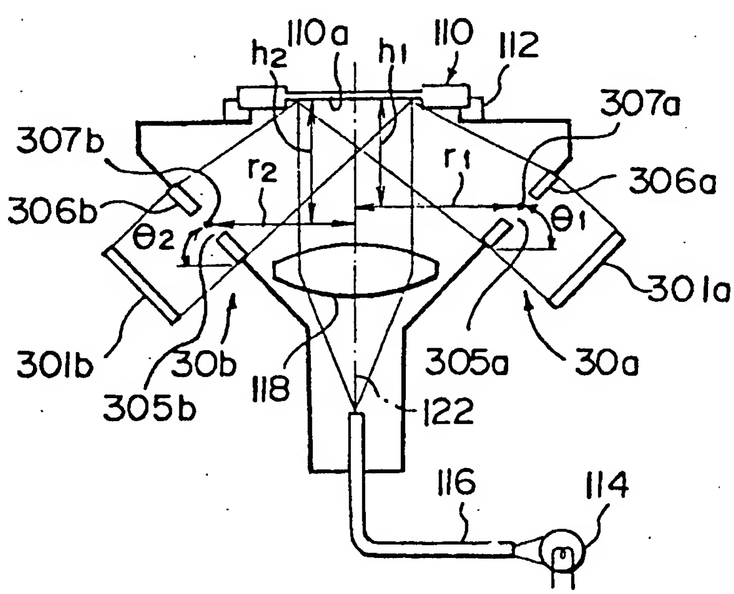

110a
h1
110
112
304a
304b
h2
r1
303a
r2
303b
θ1
θ2
301a
301b
30a
118
30b
122
116
114

FIG.11


h2
110a
h1
110
112
307a
307b
r2
r1
306a
306b
θ1
θ2
301a
301b
30b
305a
30a
305b
118
122
116
114